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ABSTRACT

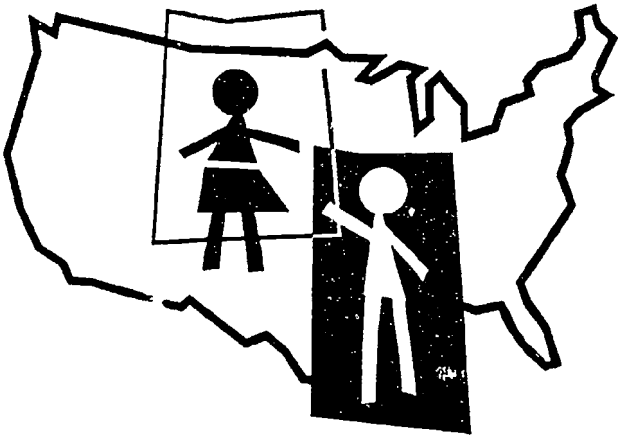
The schools of the National School Network Testbed, through their affiliated Internet-based telecommunications projects and consortia, represent the leading edge of elementary and secondary school use of the emerging digital communications network. The Baseline Survey provides a statistical portrait of the charter group of school members of the National School Network Testbed as the schools began participating in Testbed activities. This portrait will eventually be used to demonstrate, in conjunction with follow-up surveys, how participating schools have changed over the period of their Testbed involvement. The survey consisted of survey booklets for the site-based coordinator, the technical specialist, and a school administrator. This report is based on the return of 104 mainline survey questionnaires (68% of the 153 identified schools), 98 technical supplements, and 98 administrator supplements. Member schools, which are spread across the country, are located in many types of communities. Forty-three percent are high schools, 28 percent are elementary schools, and the rest represent various combinations. The schools are fairly representative of the U.S. population in terms of ethnicity and socioeconomic status. The schools differ from the average in that they tend to be innovators, with teachers disproportionately supportive of collaborative and higher-order learning. The baseline information indicates that these schools are preparing the infrastructures needed for new learning resources. The information about Testbed schools and their capabilities will be used to evaluate the implementation of new network-based teaching and learning approaches. (Contains 11 tables.) (SLD)

National School Network Testbed – Phase 2

Baseline Survey of Testbed-Participating Schools

Wave One – Schools Included as of April, 1995

NATIONAL
school network
TESTBED



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August 31, 1995

Table of Contents

Introduction

Purpose

The Baseline Survey of Testbed Member Schools fielded in April to June of this year serves two purposes: First, it provides a statistical portrait of the charter group of school members of the National School Network Testbed, Phase II (http://copernicus.bbn.com/testbed2/), as the schools began participating in Testbed activities. Second, it will eventually be used to demonstrate, in conjunction with follow-up surveys during Year 3, how participating schools have changed over the period of their Testbed involvement.

Two Stages

The Baseline Survey is being conducted in two stages, as schools are added to the Testbed population. The Spring, 1995 survey mailing was sent to the first 153 schools identified as working with (or expected to work with) Testbed member organizations. In January, 1996 another round of Baseline Surveys will be fielded incorporating schools which joined the Testbed after April, 1995.

Respondents

The Baseline Survey consists of three survey booklets, each directed at a different respondent: the site-based network coordinator or primary network-using teacher; the technical specialist knowledgeable about network hardware connectivity; and a school administrator able to provide important contextual data about the school, its organizational arrangements, and its instructional culture.

Main Baseline Survey Booklet

Most information is provided by the school's network coordinator in a 56-question survey booklet called the "Main Baseline Survey." From one item in this booklet, for example, we can compare how widespread different uses of external networks are for these leading-edge schools--uses such as electronic pen-pal activities, interscholastic collaborative product development, e-mail exchanges with adult experts, remote access of computational software, opinion exchanges, electronic field-trips, and preparing materials for network publication. Another item indicates what groupings of students comprise the interactive unit--individual students, small groups, or whole classes. The survey tells us the proportion of teachers in these Internet-active schools who are themselves active users of e-mail and what types of people network coordinators correspond with--parents, teachers personally known, teachers "met" electronically, experts outside of education, etc.

Other Booklets

The second survey booklet, the "Technical Supplement," provides data on how long different network technologies have been present at the Testbed schools, methods of access to Internet resources, and

information on financing the network infrastructure. For example, the survey tells us how many of the Testbed schools with high-speed direct Internet connections also had servers on-site and how many accessed Internet resources through other organizations.

The third booklet, the "Administrator Supplement," provides background information about the school as well as data on instructional and organizational innovations. We asked about such practices as the use of portfolios and performance assessments of students and the arrangement of having teachers work in interdisciplinary teams responsible for the same group of students.

Content of Report and Response Rates

This report from the first wave of the Baseline Survey administration provides most of the frequency distributions and some bi-variate comparisons from the fixed-choice questions for survey booklets completed and received by August 31st. Those booklets include 104 Main Baseline Survey questionnaires (68% of the 153 initially identified schools), 98 Technical Supplements (64%), and 98 Administrator Supplements (64%), or a total of 300 questionnaires (65% of those distributed).

The information from the survey is presented under nine headings:

Testbed Member School Characteristics
Hardware Resources and Connectivity
Electronic Mail Use
Network Learning Activities and Programs
Use of Internet Resources
Internet Publishing and Community Service
Support and Training
Costs and Financial Support
Perceptions About Purposes, Benefits, Problems, and Needs

Testbed Member School Characteristics

The 153 schools in the Testbed as of April, 1995 are associated with 53 different Testbed member organizations, the largest number of which (16) are school districts or intermediate units. In addition, a variety of external service providers including museums, universities, school collaboratives, commercial firms, state agencies, and pioneering individual schools provide links with Testbed member schools. Ten of the schools are themselves members of the Testbed in their own right.

Location

The Testbed member schools are spread across and beyond the United States in 21 states, DC, Canada, and US Department of Defense Schools overseas. The Northeast and the Far West tend to be disproportionately represented, with California contributing 19 schools and Pennsylvania, 17, leading all

other states. Schools in the Southeast are, so far, underrepresented in the Testbed.[1] The Testbed schools are located in many types of communities, with the five types classified--large cities, their suburbs, smaller cities, small towns, and rural areas--each contributing between 16% and 23% of the schools. Five are private schools; 148 are public.

School Level and Size

Information about the characteristics of the Testbed schools comes primarily from the Administrator Supplement. Of the 98 schools completing that survey booklet, 43% are high schools, 19% are middle schools, 28% are elementary schools, and 10% incorporate multiple levels or have unknown grade spans. The typical (median) school has 645 students, but the average (mean) enrollment is much higher--932. (High schools average nearly 1,200 students; other schools, 700).

Instructional Programs

Most of the schools are comprehensive, serving all students of a district or all those living within an attendance area. However, 26% of the schools have a magnet program for some or all students or serve a special student population. Included in this category are math/science/technology programs, International Baccalaureate programs, programs for immigrant or multi-cultural populations, general college preparatory magnets, and programs based on constructivist teaching and learning philosophies like the Coalition of Essential Schools.

Student Population

The schools are fairly representative of the US student population in terms of ethnicity and socio-economic-status. For example, 24% of the students have an African-American, Latin-American, or American Indian background, about 4 percentage points below the proportion of children from those ethnic backgrounds in the US population. Twenty-two percent of the Testbed schools' students are eligible for free or reduced lunch, and nine percent of the students were said to be limited-English proficient, a figure substantially higher than the national average (3%). Still, there are some indications of a substantial "upper-ability" presence in Testbed schools. Seventeen percent of the students were said to be in gifted-and-talented or advanced placement courses, and in three-quarters of the high schools, a clear majority of students are in college preparatory programs. Nearly one-half of respondents (45%) said that compared to students at other schools, more students at their own school had parents who were particularly knowledgeable about using computers.

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[1] That is not surprising, however. An examination of tables 6.2-6.6 and 6.9 in "Analysis and Trends of School Use of New Information Technologies," a 1994 report which we authored for the Office of Technology Assessment shows that Southern schools are substantially below the national mean on most measures of high-end technology presence and use.

Level of Instructional Innovation

Testbed schools generally tend to be innovators and their teachers disproportionately supportive of collaborative, higher-order learning and associated instructional and assessment techniques. This is particularly true among the elementary and middle schools in the Testbed population. In that group, for example, administrator respondents reported nearly twice as many teachers use collaborative learning or process-writing approaches (69% and 65%, respectively) than emphasize standardized test-taking preparation (36%). Across all school levels, "authentic assessment through performance opportunities" was said to be emphasized by nearly one-half of the Testbed teachers (49%), even more than were reported to emphasize "student mastery of basic skills (46%)."

Level of Organizational Innovation

In terms of organizational reforms, several of the innovations that are being widely advocated are reported to be present in a majority of Testbed schools. More than 80% of Testbed schools report having a school-site management council that includes teachers and 70% include parents as well. A majority of schools (54%) have interdisciplinary teacher teams with common planning periods, and nearly as many (50%) are doing performance assessments or portfolios on a school-wide basis. Forty-six percent report organized cross-age peer tutoring activities, and nearly one-third (31%) report having master teachers with mixed teaching and mentoring responsibilities. One-third of all Testbed high schools (34%) give students academic credit for community service activities. Each of these organizational innovations has potential relevance to a school's future exploitation of Internet resources. For example, teacher-teaming might assist the dissemination of network-relevant information among teachers or having community service in the curriculum might give students concrete opportunities to apply their developing telecommunications expertise.

Comparison to California Charter Schools

Our data suggest that although many Testbed schools are among the leading innovators in educational practice, there are a fair number of more "typical" schools in the Testbed, enabling the group as a whole to be reasonably representative of the country's schools. Some of the same questions about organizational reforms that were asked in the Testbed survey--questions about teacher involvement in school-level decision-making, collaborative planning by teachers, interdisciplinary teaching, and multi-aged student grouping--were also asked in a study of the new Charter schools in California, a study which also surveyed administrators in regular public schools in the same neighborhoods as the Charter schools. The Testbed school responses to each of these questions put them in between the two California groups, but, on average, somewhat closer to the "neighborhood comparison" schools than to the Charter schools. Even on a question related to instructional innovation, the Testbed schools appear to be less on the cutting edge than the Charter schools. This is not necessarily "bad" or "good" for interpreting Testbed undertakings; it merely indicates that although we have a distinctly forward-thinking and innovating group of schools, as a group they still are not as atypical of American schools as are the "break-the-mold"

NASDC schools or the Charter schools which are essentially attempting to "re-invent" schools from the ground up. (Two Testbed schools, however, do belong to one of the NASDC projects.)

Hardware Resources and Connectivity

The National School Network Testbed's effort is focused on working with network learning projects that involve schools and other end-users which have "Internet to the Desktop"--computers able to conduct Internet-based communications using the TCP/IP protocols, preferably through an Internet-connected workstation on the school's own local area network or, minimally through a modem-based SLIP or PPP connection providing TCP/IP dial-up service.

Connectivity Levels in Testbed Schools

The minimally desired levels of connectivity were realized at the time of the Baseline survey in 80% of the Testbed schools. That is, four-fifths of the responding Testbed schools by last Spring had either a high-bandwidth direct Internet connection or access to a SLIP or PPP provider. Sixteen percent had a high-bandwidth T1 line going into the school, another 33% had a lesser-bandwidth 56K line, 11% had ISDN connectivity on their regular phone line, and 10% had other direct connections, including CATV coax. Nine percent did not have a direct connection, but did have SLIP or PPP. (See Table 1, below.) Of the schools that had a digital data line or ISDN connection, more than one-half had had this for less than one year. SLIP/PPP connections, similarly, tended to be under one-year old. Almost all of the few Testbed schools that lacked any Internet connectivity as of last Spring were expecting to establish high-speed direct connections during the subsequent several months.

Number of Simultaneous Connections Possible

In a school setting, it is rarely enough for there to be a single computer with Internet access, whether via dialup terminal emulation or through a SLIP/PPP connection. Multiple simultaneous use, particularly spread throughout multiple classrooms, is essential for Internet use to become a seamless activity in the context of learning and doing in classrooms. (See data on utilization by level of connectivity in the sections of this report titled "Use of Tools to Access Internet Resources" and "Internet Publishing and Community Service.") Most of the Testbed sites with direct connections have substantial and well-distributed amounts of Internet accessibility. Of the 70% of Testbed schools with direct connections, the mean number of computers that can have simultaneous Internet connections is 59 (the median is 40). Three-fourths of the direct-connected schools can have at least 15 simultaneously connected computers, and one-fourth can have more than 70 computers connected at the same time.

Interestingly, Testbed schools below the high school level have the most distributed access to teachers' classrooms. High schools with direct connections average 10 teachers with classroom Internet access while elementary and middle schools average 19 teachers with classroom access. High schools, presumably, are more likely to have lab-based LANs rather than classroom-distributed LANs.

Server Location and Teacher and Student Email Accounts

About one-half of the schools with a direct Internet connection have an Internet server located on-site for receiving mail or for providing resources to other sites (52% of all direct-connected schools, which converts to 37% of all Testbed schools; see Table 1, below). Whether or not they have an on-site server, most schools have E-mail or user accounts for teachers on a server someplace. Eighty-two percent of all Testbed schools do, but even 73% of Testbed schools that *don't* have their own server provide email accounts for their teachers. A majority also provide accounts for students (60% of all Testbed schools, and 48% among Testbed schools without their own server). The number of different teacher and student accounts that each school had was not ascertained in the survey.

Table 1: Level of Internet Connectivity, Presence of Internet Server on Site, and Methods of Internet Resource Access

A: Level of Connectivity and Location of Servers to Access Internet Resources

	(A) % of all TB2 schools	(B) Number of TB2 schools	% of (B) with an Internet server on-site	% of (B) Without any Internet server on-site
Level of Internet Connectivity:				
56K or faster; digital or ISDN: "direct"	70.4%	69	52%	48%
SLIP/PPP	9.2%	9	0%	100%
Modems or none	20.4%	20	0%	100%
Total, all schools	100.0%	98	37%	63%

B: Electronic Mail and Location of Server
(Schools grouped by whether they have an Internet server on site)

	Server On-Site	Server Not On-Site	All schools
% with email accounts for teachers	97%	73%	82%
% with email accounts for students	81%	48%	60%

C: Level of Connectivity and Use of External Facilities to Access Internet Resources
(Schools grouped by whether they have a direct Internet connection)

% accessing Internet resources through...	Direct Connection	SLIP or Modem only	All schools
District server	49%	22%	42%
Commercial information utility (e.g., AOL)	14%	43%	22%
Research project such as Testbed partner	19%	35%	23%
University, but not with research project	15%	35%	20%

Connectivity and Use of Network Resource Providers

Most Testbed schools have had modem-based telecommunications connectivity for some time. Five of six (84%) have a modem accessible by a teacher and nearly one-half of those (40% of all schools) have had a modem for more than three years. The mean number of modems per school is three. Roughly one-half of the Testbed schools (52%) have an account on a specialized educational network, such as National Geographic Kids Network or the AT&T Learning Circles, and nearly as many (42%) have at least one account on a national information utility such as America-on-Line or Compuserve.

Testbed schools without a direct Internet connection rely much more heavily on outside providers to give them access to Internet resources. Forty-three percent of the SLIP- and modem-accessing schools use commercial information utilities like America-on-Line, compared to only 14% of Testbed schools with direct connections. (See Table 1, above.) Similarly, schools without direct connections are about twice as likely to access Internet resources through universities and research projects (such as their Testbed member's project). In contrast, schools with direct connections access Internet resources through a district-wide server more than twice as often as schools lacking that level of connectivity (49% vs. 22%).

Electronic Mail Use

Electronic mail is widely implemented, particularly among teachers, at the Testbed schools. At the "typical" (median) Testbed school, 15 teachers have email accounts. We estimate that between one-half and two-thirds of all teachers at Testbed schools may have begun using email. (Note: Size of teaching staff was not ascertained in the survey, but was estimated as 1/20 of the student enrollment.) Email is a feature of the local area networks at nearly 90% of the schools.

Internet- vs. LAN-oriented Email

More student and teacher email is directed across the Internet than to other addresses on the school's own LAN. Overall, on average, about 48% of the schools' email is Internet-based, 38% is LAN-oriented, and 14% goes over the commercial utility networks to fellow subscribers or Internet addresses. Below the high school level, LAN-oriented email is sent somewhat more frequently than Internet mail communications (46% vs. 40%), but at the high school level, Internet email is twice as frequent (58% vs. 28%). Schools lacking a direct connection use the commercial networks such as America-on-Line for about one-third (35%) of their email, but those services are essentially replaced by Internet domain names and addresses when schools obtain direct Internet connections. (See Table 2 below.)

Table 2: Approaches to Electronic Mail by School Level and Connectivity

Percent of Electronic Mail	School Level		Connectivity Level		
	High School	Below HS	Direct Connectn.	SLIP or Modem Connectn.	All Schools
LAN: Sent to others on the school's or district's own local network	28%	46%	41%	21%	38%
COMMERCIAL: Sent via Compuserve, America-on-Line and similar networks	16%	14%	7%	35%	15%
INTERNET: Sent over the Internet (and not through Compuserve, etc.)	58%	40%	52%	44%	48%
Total	100%	100%	100%	100%	100%

Electronic Mail Contacts

Most of the respondents to the Main Baseline Survey (that is, the school network coordinators or major network-using teachers) said that most of their own electronic mail is directed at educators whom they know personally. Nevertheless, a substantial number of respondents identify other groups of people with whom they have had some "regular" email contact: members of electronic discussion groups (mailing lists and newsgroups) (69% of the main survey respondents), educators "met" on the network (62%), their own students (46%), people outside of education met on the network (46%), students in other schools (35%), and parents of students (26%). Responding about the other email users at their school, a majority of respondents report that at least one teacher at their school has had regular email contact with college faculty members (65%), with librarians or other professionals (60%), and with college students (53%). In addition, between one-fifth and one-third of the respondents named each of the following other groups as being in email communication with someone from their own school--people from non-profit community organizations, local government officials, and business people.

Network Learning Activities and Programs

Formal Network Learning Projects

Many of the Testbed schools have a history of involvement in technology so it is not surprising that most of them report involvement in network learning projects even apart from their involvement in a Testbed-specific project. About two-thirds of the Testbed respondents described specific network learning projects that one or more classes at their school had participated in during the past 12 months. The list of reported projects was quite diverse although seven specific network learning projects received three or more mentions each: the National Geographic Kids Network, the AT&T Learning Circles, Mayaquest, Kids as Global Scientists, Kidslink, Live from Antarctica, and Geogame.

Teacher and Student Involvement in Formal Projects

In a majority of these specific projects (57%), two or more teachers had their classes participate. An average of 75 students per school participated in each project. Knowledge about the availability of network learning projects seems to have come to teachers and school technology coordinators more through personal contacts (75%) and conferences and workshops (76%) than through networked-based information sources, such as discussion groups and mailing lists (60%) or World Wide Web postings (59%). We expect that might change in the next few years as information about network learning oppportunities becomes widely shared among network users.

Less Structured Network Learning

We also asked respondents about the school's participation in a more heterogeneous variety of network learning activities during the school year including electronic pen-pal activities, browsing the World Wide Web, and so on. More than 80% of the schools reported at least one teacher having their classes browse the Web and an equal number indicated classes searched for specific information on-line. About 60% reported some use of electronic pen-pal activities, and close to one-half (46%) indicated that at least one teacher had students do "electronic field trips to museums, science centers, or with adults conducting a scie tific or creative activity." Less frequent, but still reported by more than one-third of the schools were collaborative writing projects (36%), collaborative science investigations (37%), cultural exchanges with classes in other places (34%), and publishing class or individual products on the network (40%). Only the use of computational software or remote control of devices was rarely reported (11% said they had). Typically, 25 to 40 students participated at any one school where an activity was employed by teachers, but for Web browsing and searching for specific information, the median number of students reportedly involved approached 100 per school.

Student Involvement by School Level

For most network learning activities, middle schools reported the largest number of participating students. Even elementary schools reported broader student involvement than high schools even though high school teachers typically teach many more students. A higher *proportion* of high schools reported student participation in some of the activities (e.g., Web browsing), but the absolute number of students per school who participated in Web browsing activities was two to three times as great at the middle-school level as among high schools. (The means for Web browsing, for example, were 248 students per middle school and 126 per high school, counting only schools where Web browsing was a reported activity.) Publishing of students' own Web pages was also more common at lower grades. In fact, the activity was slightly more prevalent in elementary schools than at secondary schools. Table 3 contains the complete data on network-based student learning activities.

Table 3: Network-Based Student Learning Activities

	% of Schools w/Any Teacher Using				Median number of students involved (where used)*			
	Elem (N=23)	Mid (N=21)	H.S. (N=46)	All** (N=102)	Elem	Mid	H.S.	All**
Searching for specific information on-line	70	75	93	81	65	150	55	93
Browsing the network using programs like Gopher or a World-Wide-Web browser	74	77	86	80	78	225	75	100
Electronic pen-pal exchanges between individual students	57	67	63	62	50	40	25	30
'Electronic field trips' to museums, science centers, or with adults conducting a scientific or creative activity	52	52	42	46	52	100	30	40
Publishing class or individual products on the network	48	36	33	40	24	30	20	25
Collaborative science investigations with classes in other places	35	29	40	37	66	45	30	40
Collaborative writing projects with classes in other places	43	32	27	36	30	36	30	30
"Cultural exchanges" with classes in other places	30	50	27	34	50	20	28	30
Using computational software or controlling devices remotely	9	5	9	11	--	--	--	25
Other learning activities using external networks	41	29	28	33	50	50	46	50

* Median enrollments by level: elementary, 517; middle, 645; high school, 1150; all schools, 651.

** Includes 12 schools with mixed school levels (e.g., K-8, 7-12, K-12) or an unknown grade span. This note applies to all succeeding tables with the column headed "All."

Involvement in All Forms of Network Learning

When we add up all of the network learning involvement represented by the activities in Table 3, we find that at Testbed schools, about 20% of the students and 14% of the teachers were involved in network learning activities during the past year.[2] The typical school had 4 different teachers and 120 different students engaged in one of the projects and other activities involving telecommunications networks. In two-thirds of all Testbed schools, at least 50 students were involved in network learning activities.

[2] Percent of students participating was weighted by student enrollment to get the overall percent of participation among the population of students in Testbed schools as a whole. This is different from the mean percent per school because the participation rate varies by school size.

Intensity and Breadth of Involvement by School Level

A "typical" student user was said to use external networks for 2 hours per week. However, high school users' involvement had more than twice the intensity as at lower grades (3.9 hours per high school user vs. 1.8 hours per middle school user and 1.0 per elementary user).[3] On the other hand, elementary and middle schools have broader participation by students, involving much larger percentages of their student bodies than high schools (29% and 31%, respectively, vs. 14% of high school students). The same is true for teacher participation, with fewer high school teachers involved in network-based teaching than at the other school levels (10% of all high school teachers vs. 18% at other levels).

Intensity and Breadth by Level of Connectivity

Schools that had already established high-speed digital (direct) connectivity reported substantially more student and teacher involvement than did other schools. Whether the higher connectivity led to greater involvement or a more network-involved culture led to higher connectivity cannot be shown; most likely both causal forces were at work. But, for example, the "hours per student user" was twice as much in directly-connected schools as in others (3.1 hours per week vs. 1.5); the proportion of enrolled students who were network users was nearly double (25% vs. 15%); and the proportion of network-using teachers was more than double (16% vs 7.7%). For almost all of the types of network learning activities in Table 3, direct-connected schools had greater participation. Nearly all (93%) had students use the World Wide Web compared to 62% of the other Testbed schools; more direct-connected schools had students do collaborative writing projects (41% vs. 29%), searches for specific information (90% vs. 68%), and Internet publishing (47% vs. 31%). The only activity where the schools with slower and less direct network attachments were clearly more involved was in collaborative science investigations, such as through National Geographic Kids Network which employs private network access.

Network Learning Activities by Class Subject

Science classes are the most common academic context for the network learning activities reported. Science classes were 32% of all specific classes identified to us. Earth science was named most often (11 times), but biology, physics, chemistry, envrionmental science, physical science, and general science were all named by at least four schools. Next to science, social studies classes had the most mentions (23%), followed by English/language arts (19%). Mathematics, computer education, and foreign language were each responsible for between 5% and 10% of all classes involved in network learning. Nearly all of the science, computer education, and foreign language classes that did network-based learning were at the middle and high school level while math, social studies, and, particularly, English/language arts, incorporated classes at the elementary level as well.

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[3] School reports of time per user were weighted by the number of students participating in network learning. This produces an average intensity of involvement for all participating students, rather than an average per school.

Network Projects of Testbed Intermediary Organizations

Among the network projects and activities that the Testbed schools are involved with are, of course, those being orchestrated by Testbed organizations through which they became Testbed members. However, at this early stage in many of the Testbed member activities, the Testbed schools display a relatively limited level of involvement, in general, in Testbed member projects. Roughly one-fourth of the schools (23%) do report that the Testbed telecommunications project in which their school is participating has already had a major impact on "much of the teaching and learning" at their school. In another 30%, the Testbed member's telecommunications project has impacted one or two teachers or several students. But in nearly one-half of the schools (47%), the Baseline survey has caught these schools, appropriately, at the starting point, not just for the Testbed itself but for the external networking efforts of the Testbed member organizations as well.

Use of Tools to Access Internet Resources

Except for six schools that, as of this past Spring, lacked Internet connectivity of any kind, all of the Testbed schools can send and receive mail to Internet addresses. In addition, between 85% and 93% of those schools can use each of the major Internet-associated tools and resources (listserv mailing lists, newsgroups, Gopher, World Wide Web, FTP file transfer, and Telnet).

Teacher use of Internet Tools and Resources

A large majority of middle and high schools report at least some teacher access of each of the six Internet resources examined. (The median percentage with any teacher use across the six resources and two secondary school levels is 82%; see Table 4.) At the elementary school level, only listserv and Web use are present in a majority of Testbed schools. Typically, between 3 and 7 teachers are actively involved in using any given Internet tool, towards the upper end of that range in middle and high schools, and at the lower end in elementary schools.

Student Use of Internet Tools and Resources

As of Spring, 1995, student use of Internet tools and resources at the Testbed schools was more focused and less eclectic than teacher use. Averaging across all six types of Internet tools (i.e., combining frequently used tools like Web browsers and less frequently used tools like FTP clients), student use (i.e., use by at least one student) occurred during the previous four weeks at only 20% of Testbed elementary schools, 38% of the middle schools, and 60% of the high schools. When students did use an Internet tool, typically 10 to 25 students were involved as users. However, the World Wide Web is in a class by itself. The median number of students using Web-browser software at schools with any users at all is 50, and that median is actually highest among elementary schools. Actually, the mean number of Web browser users per school (72 students overall, 74 at Testbed elementary schools, and 100 at middle

schools) is higher than the median, even with "non-browsing" schools included in the mean, because some schools report a very large number of Web-users.[4]

Table 4: Median Number of Teacher and Student Tool Users Among Schools With Any Use in the Previous Four Weeks (and Percentage of Schools with Any Users)

	Median Teacher Users per School (and percent with any users)				Median Student Users per School (and percent with any users)			
In the past four weeks, how many teachers or students...	Elem (N=23)	Mid (N=22)	H.S. (N=47)	All (N=104)	Elem	Mid	H.S.	All
Browsed resources via World Wide Web clients	6 at 74%	7 at 82%	7 at 93%	6 at 85%	79 at 65%	68 at 64%	30 at 76%	50 at 69%
Browsed resources via Gopher clients	2 at 44%	5 at 86%	5 at 87%	5 at 74%	* at 22%	55 at 45%	20 at 70%	25 at 51%
Received mail from 'listserv' mailing lists	5 at 61%	4 at 86%	5 at 91%	5 at 83%	* at 22%	15 at 41%	20 at 58%	18 at 44%
"Telnet"ed to other computers	2 at 52%	5 at 59%	3 at 83%	3 at 69%	* at 9%	25 at 32%	20 at 61%	20 at 39%
Downloaded files via FTP	1 at 48%	3 at 77%	3 at 76%	3 at 68%	* at 9%	15 at 36%	20 at 54%	10 at 33%
Read from or posted to newsgroup discussion groups	2 at 48%	4 at 73%	5 at 77%	3 at 67%	* at 17%	9 at 27%	15 at 53%	10 at 38%

* 5 or fewer schools with users; median not calculated.

Broad Internet Use: "Tool-Use Leaders"

Under most circumstances, teacher exploration of an educational resource is an important precursor to systematic use by students in the instructional program. Overall, our index of Internet use puts the teachers' share at 46% and the students' at 54%, and that division is roughly the same at all schooling levels. At some schools, though, student users far outnumber teacher users, and at these schools, it is likely that network use has become a more central feature of educational practice than where teacher users still are numerically dominant. At 35% of the Testbed schools, for example, the World Wide Web was "browsed" by one-tenth or more of the student body in the previous four weeks; a Gopher client program

[4] Twelve Testbed schools reported that more than 300 students or more than 40% of their student body had used Web-browser software in the previous four weeks: Glacier Valley Elementary School and Floyd Dryden Middle School, Juneau, AK; Platte Middle School, Boulder, CO; Champlain Valley High School, Hinesburg, VT; the Dalton School, New York, NY; King Middle School, Seaside, CA (a Pacific Bell/Education First school); Witherspoon Middle School, Princeton, NJ; Henking School, Glenview, IL; Evanston (IL) Township High School (a Co-Vis member school); Mendocino (CA) High School; the Gould Academy, Bethel, ME; and the Academy for the Advancement of Science and Technology in Hackensack, NJ (Coalition of Essential Schools).

was used by a tenth of the students at 15% of the schools, and each of the other Internet resources were said to have been accessed by one-tenth of the students in 5% to 10% of the schools. Ten of the Testbed schools[5] might be said to be Internet tool-use leaders in that three or more of the six types of Internet tools were used by 10% or more of their students.

Level of Connectivity and Use of Internet Resources

A necessary condition for widespread use of Internet tools is that a school has sufficient connectivity to permit many simultaneous users. Testbed schools with more than 25 simultaneous Internet connections have roughly 9 times the number of student users (averaging data across all six tools studied) as those schools with fewer than 25 connections. Nine of the ten schools identified above as "Internet tool leaders" had connectivity permitting more than 25 simultaneous users. High-speed direct connectivity through digital or ISDN connections is, for all practical purposes, a precondition for substantial levels of simultaneous Internet use. Across the six Internet resources studied, there were 74 instances where a school reported at least 10% of its students had accessed that resource in the previous four weeks. Seventy-two of the 74 were from schools with high-speed direct Internet connectivity.

However, direct connectivity is not a sufficient condition for widespread Internet use. A substantial number of directly-connected schools (29%) report less use by students than the average use among non-directly-connected schools.

Classification of Teacher and Student Use

Some teacher use, particularly in limited-connectivity environments, is on behalf of their classes (e.g., communicating questions that the students have raised). Other teacher use is for their own professional reasons (e.g., searching for lesson plans). Student use may be by whole classes together (e.g., a whole-class activity using a single connection), by small groups or teams of students, or by individual students, either for recreation or exploration or to complete a class assignment. Of the teachers' Internet use, just slightly more than half (51%) appears to be for professional work rather than as a class emissary. We would expect that the proportion going to professional work would become substantially greater as schools increase their connectivity.

Of the student use, about 20% is by a class acting together, but that approach is even less frequent above the elementary grades. Another 20% is by students working in teams to access Internet resources. Another 30% is by individual students or informal small groups for recreation or exploration, and the remaining 30% is by individual students doing work for a class assignment or project. At the middle and

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[5] The "tool-use leaders" were the Hoffman School in Glenview, IL; the Gould Academy in Bethel, ME; the Accelerated Learning Laboratory of Worcester, MA (Co-NECT Schools); Mendocino (CA) High School; the Academy for the Advancement of Science and Technology in Hackensack, NJ (Coalition of Essential Schools); New Vista High School and Platte Middle School (Boulder, CO); Lexington (MA) High School; Oceanside (CA) High School; and Paul Robeson Middle School in Kansas City, MO (Pan-Ed Institute).

high school levels, more Internet activity is recreational or exploratory than for class assignments, but the reverse is true among elementary schools. For example, high schools were twice as likely to say that "half or most" Internet use is by students for recreation or exploration than said that half or more use was "for an assignment or school project" (37% vs 17%). We would expect that over the next two years, the proportion of total network time that is spent on assignments and project work will increase substantially. That would indicate to us that network-based learning will have become an important part of the instructional repertoire of the school.

Home Access to Internet Resources

For most Testbed schools, teachers' and students' Internet connectivity occurs primarily at school rather than from home. In the survey, only among the schools that still lacked direct Internet connectivity or that had only a handful of simultaneous connections did a majority of responses (53%) indicate that most student and teacher Internet access was from their own homes.

Home access of Internet resources might be encouraged by schools in order to expand the time that students can access those resources. However, as of last Spring most directly-connected Testbed schools were not yet using their own Internet-connected LANs to enable students to access Internet resources from home. Only 29% of schools with direct Internet connections reported that students could use that connectivity by dialing in from home, although a majority of schools with direct connectivity (58%) were providing that opportunity for teachers.

Internet Publishing and Community Service

The presence of the Internet provides schools with at least two opportunities for instruction and learning which are unprecedented: the capacity for students to reach a worldwide audience with their own electronically-produced written products and the possibility of their providing service to organizations and businesses in their local community using their relatively "rare" knowledge of electronic information retrieval and telecommunications. The Baseline Survey reports how schools in the Testbed expect to make use of those capabilities in the near future.

Anticipated Content of the Schools' Internet-Based Publishing

Most Testbed schools are planning to become involved in Internet-based electronic publication in the ways that have been commonly discussed--describing school programs and events; presenting student projects such as essays, artwork, videos, and research papers; and using links and pointers to other educational resources. (More than 75% of respondents indicate each of those is planned.) In addition, a majority of schools expect to regularly publicize school events and put student statements and biographies on the Web. Fewer schools, however, indicate they will publish "student opinion about world issues" (28%), have students present surveys or questionnaires (28%), or contribute to multi-school publications (36%). Moreover, fewer than one-half say they expect to use the Internet to publish teachers' lesson plans (38%) or curriculum guides and frameworks (34%).

Experience to Date with Internet-Based Publishing

So far, 53% of the Testbed schools have students who have composed material for a Gopher or Web page and 60% have had at least one teacher who has done so. Typically (among those schools that are involved in this activity), about 15 students have done so, but just two teachers. Schools with a direct link are much more likely to have students and teachers who have composed content for the Internet (among students, 61% vs. 43%; among teachers, 69% vs. 43%). More dramatically, the number of students composing for the Internet (among the schools doing any of this) was 6 times as great in schools with direct connectivity as in the other Testbed schools (37 per school vs. 6). In composing material for the Internet, 80% of those doing so have used an HTML editor, separate from a regular word processing program. Painting and drawing programs have been used by one-half of the schools in producing documents for the Internet.

Internet Activities that Provide Community Service

In contrast to Testbed schools' active work in Internet publishing, the application of students' telecommunication skills to addressing needs and problems of organizations in their local community is beginning to occur only among a minority of schools. Nevertheless, 28% of respondents did name at least one type of organization that has become a "client" for student services. Libraries were the type of organization most commonly mentioned (by 13 respondents). Also 7 schools mentioned local government officials as recipients for student Internet effort, 7 indicated job-retraining programs, 4 mentioned non-profit health and welfare organizations, and 8 mentioned local businesses. Two schools have produced Web pages for local bed-and-breakfast facilities and one for a retial music store. Others have used their expertise to assist an elder care facility, a mail order firm, a museum, a public broadcasting station, a regional occupational program, a senior citizens center and a low income housing facility. That such relationships have already evolved is a good sign for their fruitful growth over the next two years of the Testbed.[6]

Support and Training

Responsibility for Staff Development

In most of the Testbed schools (68%), the person expected to have the primary responsibility for helping teachers to learn to use Internet resources is the school technology coordinator or media specialist. Others named by more than a handful of respondents were the district technology coordinator (41% named that

[6] Five of the Testbed schools report both substantial involvement by students in Internet publishing (more than 10% of the student body) *and* efforts to apply student telecommunications skills in service to local community organizations or firms. Those schools are the Springman School and the Hoffman School, both in the Glenville, IL district; Witherspoon Middle School, Princeton, NJ; the Academy for the Advancement of Science and Technology in Hackensack, NJ (Coalition of Essential Schools); and the Patch American School of the U.S. Defense Department Overseas Schools.

role) and the Testbed project liaison person (named by 20%). School and district-level technology specialists were also the people most often cited as the ones who were "most critical for developing your school's external computer networking program." (Each was named by 45 to 55 percent of respondents; twice as many as naming any other individual.)

Mechanisms for Staff Development

The major mechanisms for formal (compensated) training planned for after the end of the 1994-95 school year were summer workshops and in-service days. About two-thirds of the Testbed schools (66%) were expecting to have one or more in-service days during the 1995-96 school year devoted to Internet training, but typically only one or 1.5 days will be used, although at the typical school 25 teachers will be involved. Summer workshops were expected to be used by nearly as many schools (58%) and were to involve many more days (half of the schools doing summer workshops had at least 4 days devoted to Internet training), but typically fewer teachers were involved (9 is the median number). So in-service workshops were expected to involve more teachers, but those doing summer workshops provided more intensive experiences. In addition to those approaches, a substantial minority of schools (40%) were planning to provide release time on a person-by-person basis during the 1995-96 school year--including more than half of the schools that did workshops this past summer. Specific plans for release time are less clear than the other training activities, but among those who would hazard a guess, typically this will involve seven teachers for two days each.

Student Leadership in Network Training and Use

In many schools, students are beginning to take on instructional and leadership roles with respect to computers and computer networks. Even at the Testbed schools, this has been true more for helping students use computer software in general rather than telecommunications activities in particular. Still, at a majority of Testbed schools, at least one student has helped teachers learn to use networks or network software (60%) and at least one student has been locating resources and other information on the Internet for use by teachers (51%). In addition, nearly half of the Testbed schools (48%) report at least one student doing troubleshooting work on network problems. At more than one- third of the schools (36%) at least one student has been supervising other students' use of Internet tools or other network software, and also at one-third of the schools (33%) a student has "prepared documents for a teacher or administrator for publishing on the network." In spite of the breadth of this student involvement in support of network-based education, most commonly these activities have involved only two or three students per school. At only 17 Testbed schools has student leadership in network learning involved at least four students in two or more of the areas discussed above. Among the eleven Testbed schools reporting involvement of students in leadership roles across the broadest range of activities, middle schools are disproportionately included.[7]

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[7] The schools with the broadest involvement of student leadership in Internet education so far appear to include Centennial Middle School, Boulder, CO; Jefferson Junior High, Oceanside, CA; Witherspoon Middle School, Princeton, NJ; McManus Middle School, NJ; Champlain Valley High School, Hinesburg, VT; Patch American School (USDDS); the Gould Academy,

Costs and Financial Support

The cost to schools of building a network infrastructure and attaching that local network to the worldwide Internet is substantial; although it is on a scale comparable to other large technology investments such as computer labs, integrated learning system software licensing, and in-house video networks.

Costs for Establishing the Network Infrastructure

The person most technically knowledgeable at the Testbed school (or in an affiliated district or other agency) was asked to provide estimates of the total costs experienced by the school in building an Internet-attached network. Six cost elements were requested, from LAN wiring to Internet server hardware and software. Four of the elements were specific to building a local area network: (1) LAN wiring and hubs; (2) retrofitting costs beyond installing network wiring but specifically related to LAN installation (e.g., electrical work, classroom remodeling, etc.); (3) LAN file server hardware and software; and (4) connectivity enhancements to individual computers, such as Ethernet cards. Two other elements were specific to wide-area-networking to the Internet: (1) routers and similar equipment to link the LAN to external data lines; and (2) separate Internet server hardware and software. Some schools did not report costs for each element, sometimes because they had not had expenditures in that area, sometimes because they did not know what the costs were. Table 5 reports the average costs for each element, as given by schools that reported any expenditures in that category, but also as we estimate has been the costs of the "average" installation across the Testbed schools.

LAN-Establishment Costs

By far the largest portion of the networking costs are for establishing the local area network itself. Among all Testbed schools having had expenditures for a LAN and reporting cost data for each of the four of the LAN-specific elements (N=69), an average of $91,000 had been spent on LAN-specific hardware and software (the first four elements). More than one-half of the LAN costs were for accomplishing the wiring ($49,000). Slightly fewer than one-half of the schools reported retrofitting costs which, for them, averaged about $36,000. (Including the schools that spent nothing for retrofitting brings the average expenditure to about $17,000 per school.) LAN file server hardware and software cost $21,000, and Ethernet cards and the like cost about $11,000 per school. But not every school reported both of those expenditures, so on average Testbed schools with LANs spent $27,000 per school ($18K + $9K) for those two elements. The total LAN-specific costs, then, for the Testbed schools have been roughly $93,000 per school.

Bethel ME; Acton-Boxborough (MA) Regional HS; Montgomery-Blair (MD) High School; the Accelerated Learning Laboratory, Worcester, MA; and the Dalton School, New York, NY.

Table 5: Estimated Costs of Establishing LANs and Internet Connectivity

	Schools reporting some expenditure in that category		Estimated cost for "average" implementation
	average cost	number of schools	average cost
LAN-related costs			
LAN wiring and hubs	$49,000	68	$49,000
Retrofitting (electrical, room remodeling, etc.)	$36,000	33	$17,000
LAN file server hardware and software	$21,000	60	$18,000
Ethernet cards, other PC connectivity upgrades	$11,000	57	$ 9,000
Total LAN-related costs	$91,000	69	$93,000
Internet-specific costs			
Routers, etc. to link LAN to external data lines	$10,000	40	$10,000
Internet server hardware and software	$10,000	20	$ 5,000
Total Internet-specific costs	$15,000	41	$15,000
Grand Total	$101,000	69	$108,000

Unfortunately, the survey did not ask for the number of computers currently on the school LANs (independently of whether Internet access was available) so we cannot break these costs down to a per-computer basis. But we did ask about the number of *teachers' classrooms* connected to a LAN (an average of 13 per school), and can use that number to estimate wiring and retrofitting costs per room. Unfortunately, non-classroom-located "drops" such as those in a computer lab, were not enumerated, but are part of the total costs. Incorporating a certain amount for such un-measured "drops," we estimate that the average cost for wiring and retrofitting each classroom appears to be about $4,000 per room.

Costs of Establishing Internet Connectivity from Existing LANs

The remaining one-time costs for Internet connectivity are the routers and other hardware needed to link the network to external data lines and, for those schools desiring a separate Internet server, the hardware and software associated with that computer. The average cost of routers and connectors for the 40 directly-connected schools reporting that type of expense was about $10,000. The cost of an Internet server hardware and software averaged an additional $10,000 for the 20 directly-connected schools having their own server and reporting cost data on that item. If we "average" the schools that established their own server on-site and those that did not, the start-up Internet-specific costs spent by Testbed schools have been approximately $15,000 per school. Our estimate, then, of the total average cost to Testbed schools of establishing a LAN and direct Internet connectivity is about $108,000 per school--roughly

$25,000 more if infrastructural retrofitting is necessary and an on-site server is desired, $25,000 less if it is not.

Recurring Costs for Network Connectivity

Recurring costs are also a matter of concern to schools investing in Internet accessibility. But Testbed schools vary widely in how much they expect to have to pay for Internet access fees or for connecting to other networks. Based on reports from 84 schools, about one-fourth of the schools expect to pay nothing out-of-pocket because grants, projects, or other benefactors are paying the school's way. Another one-fourth, expect to pay less than $2,500. But at the high end, one-fourth of the schools expect to pay $10,000 or more. (Some schools may have been including additional one-time costs in their answer to this question.) Interestingly, high schools expect to pay much more than lower-level schools. Counting only the group that is paying out-of-pocket, the median high school expected recurring costs of about $8,700, the "typical" middle school, about $2,900, and the elementary school, about $1,800.

Sources of Funds for Network Infrastructure

School districts have been a source of funds for the development of Testbed school's network facilities in more than 8 out of 10 of these schools. Special grants, though, were mentioned by more than one-half (53%) of the schools, while state funds were acknowledged by about 40%. Financial donations from businesses were mentioned by more than one-fourth of the schools (29%), more than indicated federal funds were used (22%). Donations of time and labor from parents and students were acknowledged in 25% of the schools as well.

Sources of Future Network Funding

In terms of future funding of network infrastructure investments, a somewhat narrower pattern of support was expected. Next to district sources (which were named by 55%), two other sources were named most often--bonds and referenda which the schools expect to put before their voters (27%) and special grants (also 27%).

In terms of paying for future recurring costs, Few respondents felt that any regular governmental source above the district was likely to be a major contributor to their recurring network connectivity costs. However, in the area of training and supporting teachers, 18% of respondents mentioned the possibility of outside grant money, 13% thought that fundraising or business partnerships would contribute, and 11% hoped to get state funds.

A majority of Testbed schools reported some contribution from local businesses to their operation in the past two years (65% did). The median contribution received was on the order of $27,000. Although some of that went for network-related expenses, most did not.

Competition from Other Needs for School Expenditure

Schools reported that, of all other "competitors" that network expenditures might have for school funds (whether contributed or budgeted), the most difficult to counter were claims made for other technology expenditures unrelated to network implementation. This was perceived to be a "major" competitor at one-third of the schools (34%) and at least a "modest" competitor by more than one-half of the respondents (58%). General staffing needs and repairs to the physical plant were also perceived providing at least "modest" competition for resources but by somewhat fewer respondents (by 48% and 45% respectively), most likely because these other expenditures were considered in other contexts whereas networks and other computer expenditures were seen as alternative ways of spending the same monetary resource. Even fewer respondents regarded the needs of special students, pressure for raising test scores, or the school athletics program as providing major or modest competition for school funds (38%, 24%, and 19%, respectively).

Perceptions About Purposes, Benefits, Problems, and Needs Related To Network Learning

Who the Survey Respondents Are

The survey booklet for the major respondent at each Testbed school presented several questions inquiring about their opinions and perceptions of the values, benefits, problems, and conditions for effective use of the Internet. Three-fourths of these respondents (76%) were technology or networking coordinators for their school, and this group was equally likely to be formally designated as such or acting as an informal coordinator for technology or networking. A slight majority of the respondents were also currently classroom teachers (52%), including two-thirds of the "informal" coordinators and one-third of the formally designated coordinators. One-fourth of the respondents had other roles in the school or in the Testbed project, most commonly media specialist or district computer coordinator.

One third of the respondents worked fulltime on technology-related activities, but for the others, technology coordination averaged about one-half (46%) of their workweek. For both the full-time coordinators and the other respondents, about one-half of the time they spent on technology was spent on network-related activities (48% of total technology coordination time)--that is, on using and teaching others about LANs, the Internet, and commercial networks.

Educational Values of the Internet

Respondents were first asked to rank-order five different educational values of the Internet in terms of how valuable they will be for teachers and students at their school two years from now. Of the five, one was clearly thought to be more important than the others--that the Internet will provide "access to a huge variety of curriculum-relevant information for teachers and students." Nearly one-half of the respondents gave this their top ranking and two-thirds placed it first or second. (Table 6 below shows the exact percentages.)

The second-ranked value was that the Internet enable "students to participate in research and problem-solving with scientists and other specialists." This choice was ranked first or second by two-fifths of the respondents. Thus, real-world learning experiences that link students to adults was also a valued capability.

Table 6: Ranking of How Valuable the Internet will be for Students and Teachers

	% of Respondents Giving Indicated Ranking*				Overall Rank by School Level			
	1st	2nd	3rd	4-5	Elem	Mid·	H.S.	All
Provides access to a huge variety of curriculum-relevant information for teachers and students	46	21	15	18	1st	1st	1st	1st
Enables students to participate in research and problem-solving with scientists and other specialists	18	22	27	32	4th	2nd (tie)	2nd	2nd
Enables students to communicate with other students across the world	5	26	22	47	2nd	4th	3rd	3rd
Provides a worldwide audience for each student's work, therefore making writing and other academic tasks more meaningful	15	16	21	49	3rd	2nd (tie)	4th (tie)	4th
Enables teachers to actively collaborate with other teachers across the country who share similar interests	6	18	26	50	5th	5th	4th (tie)	5th

* Columns do not total to 100% because tie rankings were given intermediate ranks--e.g., a tie between 1st, 2nd, and 3rd place was coded "2nd" for all three tied values.

The other three values--all reasonable choices as well--were generally ranked below the first two. These choices were, "(enabling) students to communicate with other students across the world," "(providing) a worldwide audience for each student's work, therefore making writing and other academic tasks more meaningful," and "(enabling) teachers to actively collaborate with other teachers across the country who share similar interests." As important as are the values of student-to-student communication, teacher-to-teacher communication, and the opportunity for publication of student work, these three goals were seen as a lower priority compared to student involvement in adult-directed real-world problem-solving outside the confines of the school or enlarging the pool of intellectual and academic resources for students to examine and use in their classroom work.

Purposes for Providing Internet Access

In the second opinion question, respondents were asked about their "purposes" or reasons for providing Internet access in their school. They were presented with a list of eleven different reasons for using the Internet (from "make the curriculum more interdisciplinary" to "develop better relationships between teachers and parents"), and they could circle as many as they found appropriate. (See Table 7 below.) A majority of respondents selected eight of the eleven, but there was most consensus around three purposes. One was similar to the top-ranked choice of the previous question: "Increase the information and computational resources accessible to classrooms." But two others were quite distinct: "change the focus of learning from ingesting information to constructing understanding" and "enable students to be more responsible for their own learning." Each of those three was selected by 80 to 90 percent of the respondents. Several of the reasons were selected much less frequently--for example, "enable students to use computer skills to serve their communities (selected by 51%); "make learning more visual" (47%); and "develop better relationships between teachers and parents" (34%). Table 7 provides the percentage of respondents checking each item, by school level. One interesting comparison is that having students use the Internet to "serve their communities" was endorsed much less frequently at the high school level than at middle schools, even though one could argue that these older students are in a better position to do so than their younger brothers and sisters.

Table 7: Purposes for Providing Internet Access in their School

	% of Respondents Selecting that Item			
	Elem	Mid	H.S.	All
Increase the information and computational resources accessible to classrooms	87	91	89	90
Enable students to be more responsible for their own learning	78	95	83	86
Change the focus of learning from ingesting information to constructing understanding	78	82	85	83
Make the curriculum more interdisciplinary	74	100	66	75
Enable scientists and other 'experts' to contribute to children's learning	61	82	64	71
Help teachers become more knowledgeable professionals	65	86	70	71
Make learning more concrete by providing meaningful contexts	70	86	64	70
Enable students to use computer skills to serve their communities	52	77	4[illegible]	51
Make learning more visual	63	59	47	47
Develop better relationships between teachers and parents	35	45	30	34
Help teachers control the curriculum they teach	35	36	21	26

Benefits Observed from Network-Based Teaching

Third, we asked these respondents to tell us, from their observations so far of students in network-based learning activities, what benefits they have observed "in a substantial proportion" of student users. Each of the nine items we listed (see Table 8 below) was chosen by more than 30% of the respondents--only 12% said that they had observed none of the suggested benefits. When asked which two or three benefits they had observed "most often," the item selected most frequently was that "student apply themselves for longer periods of time." Other benefits "most often" observed were that "students take on more responsibility for their own learning," "average kids are communicating and producing in ways only gifted kids did before," and "students are better working collaboratively with peers.

Table 8: Benefits Observed in Student Network Users

	% Indicating Benefit Observed in "a Substantial Proportion of Student Network Users"			% Indicating Benefit as One of the 2-3 "Most Often Observed"		
	Direct connect	Other schools	All	High schools	Other schools	All
Students apply themselves for longer periods of time	62	65	65	41	38	40
Students take on more responsibility for their own learning	61	77	67	37	30	33
'Average' kids are communicating and producing in ways only 'gifted' kids did before	44	54	48	29	36	33
Students are better at working collaboratively with peers	66	54	64	39	26	32
Students take more interest in world events and foreign cultures and societies	52	58	54	7	24	16
Student expertise is more equally distributed--less concentrated in a few 'high ability' students	44	35	41	20	12	15
Students have a deeper understanding of the ideas they encounter	34	27	32	17	12	14
Students have more interest in understanding the 'adult' world (e.g., scientists, business people)	44	42	40	10	14	12
Students are more able to communicate with adults they do not know personally	48	42	43	17	6	11

Table 8 provides the response distributions for each item, separately for schools with direct Internet connectivity and for other Testbed schools. Respondents at schools with direct Internet connections

reported observing two of these benefits more than respondents at other schools. They were somewhat more likely to observe a broader distribution of expertise and they were more likely to observe peer collaboration. That more differences did not appear may be due to these opinion questions functioning more like indicators of general attitudes towards network learning rather than accurate observations of teaching experiences.

The right-half of Table 8 presents results about the two-to-three benefits "most often" observed, separately for high schools and other school levels. High school respondents more often reported students able to communicate with adults and working with their peers as a result of their Internet experiences, while the benefit more often observed at lower grades was students taking a greater interest in world events and foreign cultures.

Problems Experienced in the Use of External Networks

To balance the question about "benefits observed," we also asked about "major problems that have come up regarding use of external networks." (See Table 9.) Three problems were each identified by about one-half of the respondents: slow or unreliable network performance, "information overload", and the difficulty of finding the specific information being sought. These were also the items called "the most important problems encountered," along with two others: the unavailability of technical support and an insufficient number of network connections for a class of students to use the network effectively.

In contrast, respondents were generally satisfied with such things as the ease of accessing the network, quality of material found there, and the ability of low-achieving students to use network software. Furthermore, they had not yet reached the point of complaining about "electronic mail in-baskets (bein overloaded"! The much discussed issue of pornography was checked as a problem by about one-thir the respondents, but only 13% regarded it as one of the two or three "most important problems." Sir (that is, intermediate) levels of dissatisfaction were recorded for "no time in the schedule to make use the network" and "inconvenience of Internet access locations" with about one-fourth of the responde reporting difficulty in these areas.

The problem most often identified by schools lacking a direct connection was "not enough connecti be made at the same time for a class to use (the network)." That problem was reduced in half for t schools with direct Internet connectivity. High school respondents were more apt to be concerne sufficient connections and about technical support (see right half of Table 9), while schools servi younger students more often expressed concern about the difficulty of finding information on the to answer specific questions.

Table 9: Problems Experienced in Use of External Networks

	% Indicating Problem Experienced			% Indicating Problem as One of the 2-3 "Most Important Problems"		
	Direct connect	Other schools	All	High schools	Other schools	All
Hard for teachers or students to find the specific information they are seeking	55	48	53	19	35	28
Slow or unreliable network performance	55	48	52	29	25	27
Information overload--too much to know what to do with	46	63	50	19	27	23
Not enough technical support available	38	44	40	33	23	28
Not enough connections can be made at the same time for a class to use	28	59	38	38	25	31
Students have too easy access to pornographic material	35	33	35	12	13	13
No time in the school schedule for using it	29	30	27	14	15	16
Computers with Internet access are inconveniently located	22	33	25	17	8	12
Too complicated to access the network	14	22	16	0	4	2
No clear educational reason for using it	20	7	15	5	4	4
Electronic mail in-baskets are overloaded	15	11	13	0	6	3
Generally low quality of material found on the network	12	7	10	2	0	1
Difficult to use with low-achieving students	5	4	4	5	2	3
Other	23	11	19	17	15	16
No major problems	5	0	5	--	--	--

What is Required to Make the Internet More Attractive and Useful?

To reach the educational potential of having Internet connectivity in schools, developers and school planners must be attentive to the conditions which will make such connectivity more useful for teachers in the midst of their other ongoing responsibilities. Two groups of teachers might be identified here--those who are among the innovators who have already taken an active interest in telecommunications; and more "typical" teachers who have not shown interest so far. The technology coordinators and the others who responded to the Main Baseline Survey instrument were asked for their opinion regarding the factors that would make Internet use most useful and attractive for these two groups of teachers. Although some factors were common to both groups of teachers, there were some differences as well. Table 10 shows what they are. (Note: the questions asked about the two groups of teachers were somewhat different, but we nevertheless find them similar enough to treat together.)

Table 10: Factors Perceived to Make Internet More Useful and Attractive for Teachers

	% Indicating Factor "very important or essential" to make Internet useful for already-interested teachers (rank order in parentheses)				% Indicating Factor "will make Internet use most attractive" for teachers not yet showing interest (rank order in parentheses)			
	Elem	Mid	H.S.	All	Elem	Mid	H.S.	All
Classroom location for Internet access	86	81	85	84 (2)	83	95	83	86 (1)
Access to World Wide Web browsing	70	90	87	82 (3t)	61	91	83	78 (2)
Electronic mail to Internet addresses	91	77	78	82 (3t)	52	82	70	70 (3)
A larger group of teacher colleagues at the same school also using the Internet	65	55	63	64 (7)	74	64	66	68 (4)
Easier and better information-search-and-retrieval tools	74	73	67	69 (6)	61	73	62	67 (5)
Packaged instructional materials and lesson plans for using Internet resources	44	27	37	36 (12)	74	50	66	64 (6)
Internet access for many computers at the same time	83	91	87	85 (1)	48	68	68	61 (8t)
Direct Internet connection rather than modems	83	77	74	78 (5)	52	64	62	61 (8t)
More relevant types of information (e.g., curricular materials, student activities)	70	50	50	53 (10)	39	68	70	61 (8t)
More support from administrators	65	55	60	62 (8)	39	45	57	51 (10)
Ability to "publish"--make student work available via the Web or gopher	52	64	51	55 (9)	35	55	34	40 (11)
Better quality of information on the network	61	50	33	47 (11)	22	55	26	33 (12)

For Already-Interested Teachers

Respondents believed that four factors are most important for making the Internet most useful for teachers who have already taken an interest: (1) having Internet access in their own classroom; (2) having Internet access for many computers at the same time; (3) being able to browse the World Wide Web; and (4) being able to send and receive electronic mail through the Internet. Right behind those is direct Internet connectivity in place of modems and SLIP connections.

For Teachers Who Are Yet to Show Interest

To make the Internet attractive to teachers who have not yet shown an interest, the most important factors cited were classroom access and ability to browse the World Wide Web.

Some Results Worth Noting

Combining the answers for both groups of teachers, needs that were *least often* selected by school respondents were the ability to publish student work via the Web or Gopher and "better quality of information on the network." If Testbed project managers believe those attributes are important, they may have some convincing of teachers to do! The availability of packaged instructional materials and lesson plans for using Internet resources was another feature not considered to be important for the currently interested teachers (only 36% named that item). However, packaged instructional materials and lesson plans were felt to be important to enlist the involvement of more "typical" teachers (64%), a group which is an important target of the Testbed with its focus on building a broad user base of teachers within member schools.

Among high school and middle school respondents, Web-browsing was felt to be the most important factor for improving the attractiveness and utility of the Internet, but this was less frequently stated by elementary school respondents.

Directly-Connected Schools vs. Others

Although not shown in the table, schools with direct connections differed from other schools on three factors as being "very important" or "essential" for making Internet useful for the already-interested teachers. They were more likely to endorse the need for direct Internet connections to replace modems (83% vs. 70%), simultaneous access for many computers (92% vs. 70%), and easier and better information-search-and-retrieval tools (72% vs. 56%). Interestingly, respondents at direct-connected schools were somewhat *less* likely to believe that the ability to publish student via the Internet was a selling point for the already-interested teacher (50% vs. 63%).

Barriers to Participation in Network Learning Projects

Finally, survey respondents answered two questions about problems or needs relevant to participation in network learning projects--one a general question about barriers that led them to reject participation in certain projects and the other about their current needs which they hope Testbed participation will help address. In the former question, about barriers to project participation, 90% of the respondents selected at least one item in the list. The most common difficulty encountered (by 45%) was the requirement of having to fit into a specific schedule of activities. Projects that are not time-bound in the way that many collaborative projects or electronic field trips are can be implemented more easily. The second two most-mentioned reasons were (a) the total amount of class time the project required and (b) computer connectivity requirements. These were each selected by 33% of the respondents. Those three factors were

more important, on the whole, than issues of curriculum match, the financial cost to participate, or other issues that respondents mentioned on their own.

Aspirations for Testbed Participation

As for what they are hoping to get out of Testbed participation, the most striking fact is that all but one of the nine items listed was selected by 48% or more of the respondents. The average respondent selected more than 5 of the 9 items proposed. That they have needs in this area goes without saying! Of the nine choices (see Table 11 for the complete results), more respondents focused on curriculum and instructional issues than on technical ones. The two choices most frequently checked were "learning how to integrate network learning into the curriculum" (87%) and "identifying instructionally useful collaborative class projects" (81%). Social and financial support were the next most commonly chosen needs: "Becoming involved in a community of other interested (and interesting!) teachers doing network teaching" was selected by 73% and "identifying funding opportunities for supporting curriculum development of network projects" was chosen by 62%, a choice that reflects the need for both financial support and curriculum development. The overall impression one gets from the data in Table 11 is the high priority given by Testbed members to sharing ideas and acquiring information about curriculum content and instructional opportunities available through the Internet.

Table 11: Aspirations for Testbed Participation--Major Needs

	% of Respondents Selecting that Item			
	Elem	Mid	H.S.	All
Learning how to integrate network learning into the curriculum	91	91	84	87
Identifying instructionally useful collaborative class projects	73	73	89	81
Becoming involved in a community of other interested (and interesting!) teachers doing network teaching	77	64	73	73
Identifying funding opportunities for supporting curriculum development of network projects	59	64	62	62
Learning how to use the Internet tools and information resources that exist	50	50	53	53
Obtaining new Internet tools and resources	41	59	51	49
Identifying funding opportunities for network hardware and connections	50	45	53	49
Gathering ideas for how to extend knowledge about networks to other teachers at the school	50	41	49	48
Obtaining quick, informal help in troubleshooting network problems	27	45	42	39

A Final Word

The schools of the National School Network Testbed, through their affiliated Internet-based telecommunications projects and consortia, represent the leading edge of elementary and secondary school exploitation of the emerging international digital communications network. The Baseline Survey demonstrates that these schools are preparing the infrastructures necessary for them to begin to take advantage of these new learning resources. The survey also demonstrates the nature of the task ahead of them--to complete the connectivity of their schools and classrooms, to develop technical expertise among their teachers, and, most importantly, to use their considerable expertise in subject-matter and pedagogy to recast the nature of school-based learning and instruction to better fit the opportunities and demands for an educated population to inhabit the next century. During the next two years, we will continue to monitor Testbed member schools and the growth of their understanding and application of these resources. Our principal interest will be to document how their understanding and resource exploitation advances and the direction it takes. In addition, we will be studying the facilitating conditions that differentiate the more successful from the less successful Testbed schools. That analysis will enable us to better advise other schools, coming along slightly later, as to how to be most effective and efficient in their efforts to build their own capacity for network-based teaching and learning.